US Army Corps of Engineers Sacramento District
Hawthorne Army Depot
Hawthorne, Nevada

Decision Document

Solid Waste Management Unit A05
Mustard Gas Disposal Area

June 2001

TETRA TECH
180 Howard Street, Suite 250
San Francisco, CA 94105

Hawthorne Army Depot
Unit A05

Decision Document SWMU A05 Mustard Gas Disposal Area

Reviewed: December 12, 2001
By: Ken Scarbrough
Received: November 15, 2001
Author:

General Comments:

- The document is well written and provides a good description of the work conducted at the SWMU.

NDEP Concerns:

- Section 8.0 Conclusions: This section States, "restrict all surface and subsurface activities within the encompassing security fence or at any other areas within the SWMU boundary." This statement needs to be revised to state that all the area within the SWMU boundaries would be restricted.
- Figure 1-1: This figure identifies the location of the interior security fence. However, Sites DA-1, P-1, DA-11 and P-17 are outside of the security fence. A review of the Final Remedial Investigation Report indicates that these areas were not fenced because, "These areas were smaller isolated disturbed soil areas assessed as not being likely to contain chemical agents disposal; therefore, the cost benefit of including these areas within the interior security fence was not warranted." – Revised Page 3-7. Costs benefit should not be the primary factor for not fencing these areas. Land restrictions should be based on potential for exposure.

  NDEP has also researched the 1988 field observation notes included in the Final RI Appendix C indicating that location P-17 was observed to contain 250 ml amber bottles and crates on the surface. The other three locations do not describe the field observations and are assumed to have been just disturbed native soils. The Appendix data indicates that location P-17 had one surface sample (3 foot depth?) taken for TEU with the results being negative. It is unclear what analyses were conducted.

  NDEP requires additional information concerning the analyses conducted at location P-17 and additional information for not fencing this location.

Decision Document SWMU A05

June 2001

The selected remedy is protective of human health and the environment. It has been shown that a complete pathway to human health and the environment does not exist, and there is no potential for an exposure pathway to be completed in the future.

US Army

13 NOV 2001

Anne L. Davis
Lieutenant Colonel, U.S. Army
Commanding

State of Nevada

18 Dec 2001

Paul Liebendorfer
Chief, Bureau of Federal Facilities

Decision Document for Closure of

Solid Waste Management Unit A05
Hawthorne Army Depot
Hawthorne, Nevada

1.0 INTRODUCTION

This decision document describes the rationale for the proposed closure of SWMU A05 at the Hawthorne Army Depot (HWAD), Hawthorne, Nevada. This document was prepared by Tetra Tech, Inc., for the US Army Corps of Engineers, Sacramento District (USACE).

Tetra Tech (Tt) and International Technology Corporation (IT) were tasked by the USACE, to perform remedial investigations at SWMU A05, which were conducted from 1988 through 1997. The investigations included surface and subsurface sampling and geophysical data acquisition. The primary goals of the investigations was to assess the environmental impacts and to report the findings, to present conclusions, and to recommend remediation, if necessary. The attached Figure 1-1 illustrates the area at SWMU A05 where these investigation activities occurred.

2.0 SITE HISTORY

SWMU A05 covers approximately 400 acres in the eastern portion of HWAD's south magazine area, approximately two miles south of US Highway 95 at the foot of the Garfield Hills. SWMU A05 has a perimeter fence along the north, west, and south sides to prevent access by onsite personnel. The east side access is limited by Garfield Hills. According to HWAD personnel and based on field evidence, the southern portion of SWMU A05 was used in the disposal and chemical destruction of the toxic agents mustard, phosgene, and cyanogen chloride during the 1940's.

Literature research of "Mustard Gas" indicates that the term refers to several chemicals; however, it typically refers to sulfur mustard which was the primary agent used in Army munitions. Mustard gas when pure is a clear and odorless liquid. It is brown when mixed with other chemicals and typically has a garlic smell. It readily dissolves in fats, oils, alcohol, gasoline, and stirred water but dissolves slowly in unstirred water. If mustard gas is buried underground, it may not disappear for several years. Mustard gas does not readily migrate through soil to underground water (Draft Toxicological Profile for Mustard Gas, Agency for Toxic Substances and Disease Registry, September 2001).

The general procedure for disposing of these chemical agents was to excavate a 20- to 30-foot deep trench and partially filling it with coarse gravel. Charges containing the toxic agents were removed from the munitions, and the agents were poured onto the gravel. All of the munitions' components, including the empty charges, were placed in the trenches on top of the gravel. The agents within the gravel and any residual agents on the munition components were neutralized by flooding the trench with a supertropical bleach solution, which was a mixture of calcium hypochlorite and lime. The disposal was completed by backfilling the trench with native soil to grade.

The USACE, HWAD, and the Nevada Department of Environmental Protection (NDEP) agreed to define the boundaries of SWMU A05 using annotated monument and survey pins. As part of the 1997 field investigations, Tt placed a survey monument at SWMU A05, designated with the monument designates the monument number, HWAAP-31-1996, and the SWMU number, A05. This monument was placed near the center of the reported disposal area so that investigation activities in this area could be near this known coordinate location. The boundary corners of the SWMU also have been surveyed, with monuments constructed at the corners. These corner monuments are designated MON 13, MON 14, MON 16, and MON 17. The boundary lines of SWMU A05 are defined by a barbed wire fence on the north, south, and west sides and by a line that connects monuments MON13 and MON17 on the east side. The locations of these monuments and the SWMU boundary are shown on Figure 1-2.

3.0 SITE CONDITIONS

Tt's 1993 site inspection of SWMU A05 found mostly flat areas with no surficial evidence of the previous chemical agent disposal trenches. A fenced area was found in the disposal area, but this fence did not enclose all of the disposal trenches and its purpose was not known. No distinguishing differences of the ground surface inside and outside of this fenced enclosure was apparent. Previous inspections at the SWMU have found unexploded ordnance (UXO) and UXO-related debris.

There are no groundwater monitoring wells in the vicinity of SWMU A05; however, the depth to the shallowest groundwater was estimated to be approximately 250 feet to 300 feet below ground surface (bgs), based on the depth to groundwater in the HWAD supply well NAD-3, measured during the US Army Environmental Health Agency (USAEHA) survey in 1974 (USAEHA 1988[1]). This well is approximately two miles northwest of SWMU A05. During Tt's 1994 remedial investigation of SWMU A05, Norcal Geophysical Consultants, Inc., (Norcal) of Petaluma, California, performed a seismic refraction survey to assess the depth to the shallowest groundwater and to better define the local groundwater gradient in the shallowest aquifer in the vicinity.

4.0 INVESTIGATIONS

The Navy investigated SWMU A05 in 1971 (Kopp 1971[2] and USATHAMA 1977[3]), and IT investigated it in 1988 (IT 1989[4]). The Navy identified and excavated several disposal

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[1] USAEHA. 1987-1988. Final Report. Ground Water Contamination Survey No. 38-26-0850-88. Evaluation of Solid Waste Management Units. HWAAP, Hawthorne, NV, 12-19 May 1987 and 1-5 August 1988.

[2] Kopp, C.V. 1971. Investigation of Possible Contamination Hazard at an Old Mustard Gas (H) Munitions Burial site on the U.S. Naval Ammunition Depot. Vulnerability Branch, NWL, Dahlgren, VA.

[3] USATHAMA. 1977. Installation Assessment of Naval Ammunition Depot, Hawthorne, NV. U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, MD. Records Evaluation Report No. 114.

[4] International Technology Corp. (IT). 1989. Final Report Ordinance and Environmental Investigation at HWAAP, Hawthorne, NV, Volume 1, 2, 3 and Appendices A-G, CEHND, May 1989.

pits. IT's 1988 detailed MAG and EMAG surveys resulted in the mapping of a contiguous group of disposal sites covering 18 acres in the southern portion of SWMU A05. In 1988, IT excavated and sampled 15 of the mapped disposal sites. Because of the potential health and safety hazards of encountering chemical agents, the field activities were performed solely by the Army Technical Escort Unit (TEU) in level B personal protective equipment. Sixty-three soil samples were collected during the 1988 exploratory excavation program.

Tt investigations at SWMU A05 from 1993 to 1997 were focused on nonintrusive mapping of disposal sites and groundwater studies, both using geophysical methods. Disposal site mapping was done using airborne ground-penetrating radar over 300 acres. The objectives of the study was to explore for additional disposal sites within, and peripheral to, the contiguous group of pits and trenches investigated previously and to verify the locations of the previously investigated disposal trenches.

During Tt's 1994 remedial investigation of SWMU A05 Norcal performed a seismic refraction survey to assess the depth to the shallowest groundwater in the vicinity of the chemical agents disposal area at the SWMU.

Based on Final Report Addendum to the Remedial Investigation Report Solid Waste Management Unit A05, June 2001 and agreement with NDEP/HWAD/COE/Tetra Tech, monitoring wells were not required to investigate the groundwater.

5.0 INVESTIGATION RESULTS

The Navy and IT found bleach containers, bomb casings, bombs, floating smoke pots, and munitions used for mustard, cyanogen chloride, and phosgene in 15- to 18-foot excavations at identified disposal sites in the southern portion of SWMU A05. Traces of mustard were found with an M-18 field detector inside one bomb case and in two soil samples during the 1971 Navy excavations of trenches T-1 and T-3 (Figure 1-1). However, none of IT's 1988 soil samples collected from 15 exploratory excavations returned positive readings in laboratory tests for mustard or other target analytes. Based on its investigation, IT concluded that mustard had been mostly destroyed in the reaction with the supertropical bleach because of the presence of active chlorine and the absence of thiodiglycol. However, these investigations were limited to a maximum depth of 15 feet, which was not deep enough to encounter any of the gravel reportedly placed in the bottom of the disposal trenches where the mustard would have been at its highest concentration, and it is not known whether chemical agents persist in the gravel beds or in the native soils below a depth of 15 feet.

Due to the potential health & safety risks and costs of conducting further subsurface soils investigation; HWAD, USACE, and NDEP agreed that additional investigations would be limited to nonintrusive activities. Results of these investigations (Tt's 1994 to 1997) identified four potential disposal sites in the southern portion of SWMU A05 outside the central area of known chemical disposal activities. These sites are designated DA-1, P-1, DA-11, and P-17 (Figure 1-1). The sites are small, isolated, disturbed soil areas assessed as unlikely to contain chemical agents.

The geophysical study of the groundwater was a refraction seismic survey that produced two subsurface profiles in the area of the disposal site. These profiles showed a seismic strata at approximately 150 to 300 feet bgs, where the shallowest groundwater likely occurs. This data supports the USAEHA estimate of 250 feet to 300 feet bgs depth of the shallowest aquifer (USAEHA 1988[5]). In the arid desert environment at HWAD, there is little surface and near-surface water leaching to the groundwater that would transport the target analytes at this SWMU to the groundwater level; therefore, it is unlikely that any chemicals in the soils at a depth of approximately 20 to 30 feet in the disposal trenches have migrated to the groundwater at a depth of greater than 200 feet.

6.0 REMEDIATION

Remediation of the trace amounts of mustard known to exist at SWMU A05 is not required or recommended, due to the low levels and potential risks involved with excavating and isolating the target analytes. However, due to the potential for greater concentrations of mustard gas in the gravel zone and UXO, Tt recommended isolation of the central disposal area. The proposed isolation method was to construct an interior security fence around the 18-acre contiguous disposal area. The fence was to consist of locking gate, topped with barbed wire, and metal warning signs identifying the potentially dangerous condition inside the enclosure. In addition, Tetra Tech recommended that HWAD control all access and limit any subsurface activities at SWMU A05.

Based on field observations (surface and excavation activities), soil sampling, and geophysical investigations, the four sites (DA-1, P-1, DA-11, P-17) located west/southwest of the interior fencing were identified to be small, isolated, disturbed soil areas assessed as unlikely to contain chemical agents and therefore were not included in the SWMU interior fence. SWMU A05 perimeter fencing would provide access control to these sites.

7.0 REMEDIATION RESULTS

The closed, encompassing 18-acre interior security fence at SWMU A05 has been constructed to the standards listed in the USACE scope of work. Warning signs are attached to the fence along all sides of the enclosure and at the locked access gate. By restricting foot and motorized traffic, the risk of accidental human exposure to potentially hazardous compounds inside the barbed wire enclosure has been greatly reduced. Additional isolation of the area is provided by the fence around the 400-acre SWMU A05 area, by the south magazine encompassing perimeter fence, and by continuous 24-hour security patrol by the HWAD base operator. Furthermore, HWAD has documented that no surface or subsurface activities are allowed within the encompassing interior security fence at SWMU A05 or at any other areas within the SWMU boundary without review and approval of the Government Environmental Office.

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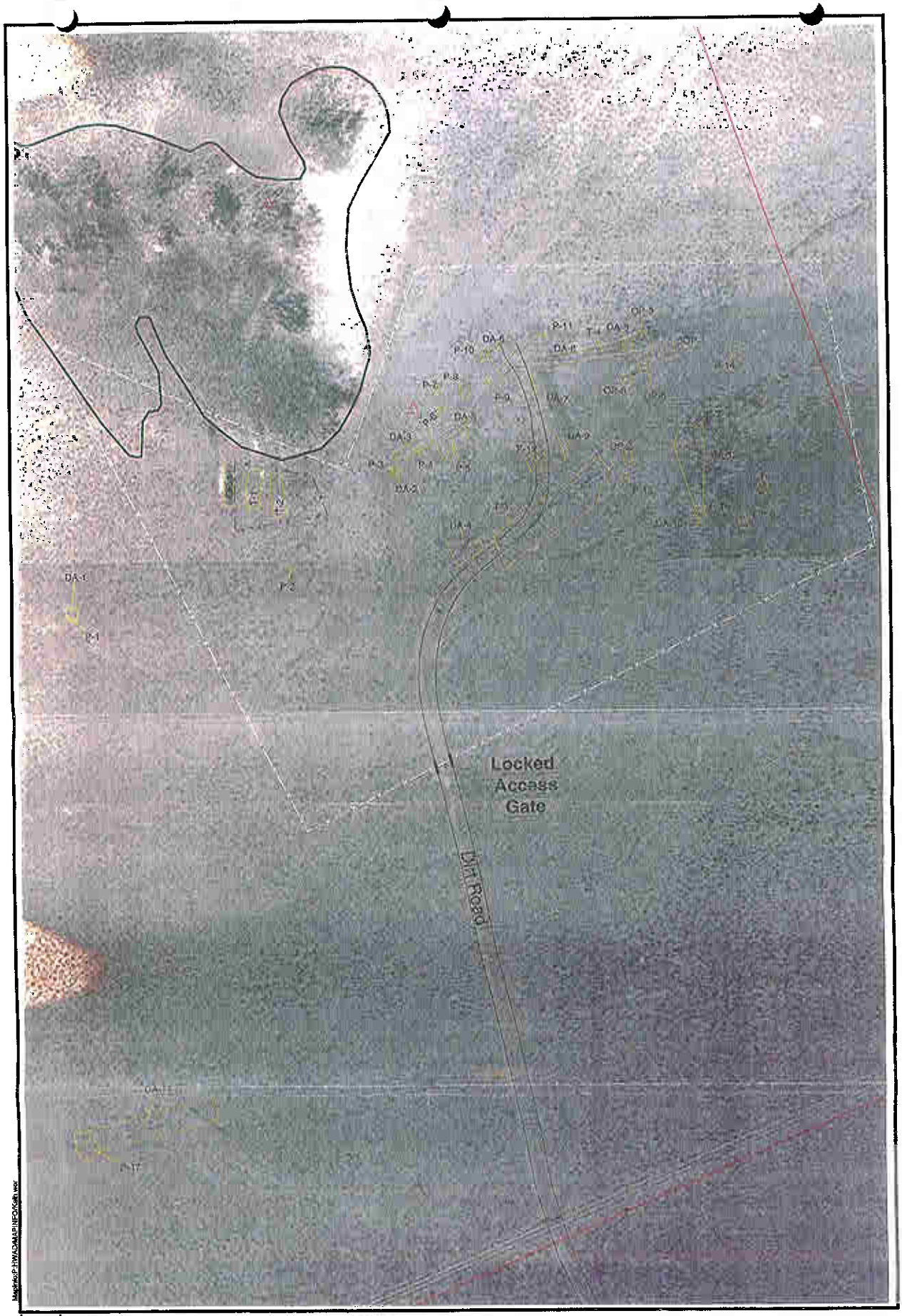
[5] USAEHA. 1987-1988. Final Report. Ground Water Contamination Survey No. 38-26-0850-88. Evaluation of Solid Waste Management Units. HWAAP, Hawthorne, NV, 12-19 May 1987 and 1-5 August 1988.

8.0 CONCLUSIONS

Based on records research and field investigations conducted between 1971 and 2001, an 18-acre site located in the southern portion of SWMU A05 was formerly used to dispose of chemical agents. The primary agent disposed was sulfur mustard typically called mustard gas. The fieldwork consisted of excavation activities, soil sampling, and geophysical investigations. The work identified trace amounts of mustard gas located in the native soils to backfill above the reported gravel placed in the trenches allowing rapid neutralization of chemicals by exposure to the air and supertropical bleach solution. An evaluation of gravel zone was not completed due to depth, costs and exposure potential to field personnel. However, a review of the depth of groundwater in the area (200 to 300 feet below ground surface) and the nature of mustard gas (limited migration potential in soils and degradation due to HWAD naturally occurring basic soils), the potential for migration below the engineered gravel zone is very limited.

The only likely exposure potential from this site was evaluated to be from surface and subsurface excavation activities. This exposure potential was addressed by the controls placed on the SWMU A05 perimeter fencing and an 18-acre interior security fence around the central disposal area. Additional land use restrictions (LUR) consist of no surface or subsurface activities within the interior security fence and all other activities conducted in the remaining portion of SWMU A05 require HWAD Government Environmental Office review and approval.

FIGURES



Legend:

- Existing Fence
- SWMU Monument
- Rock Outcrop
- Inferred Extent of disrupted Soil from Radar
- Security Fence

P Pit from Radar
Op Open Pit
T Trench from Radar
DA Disturbed Area from Radar

N

0 100 200
Approximate Scale in Feet

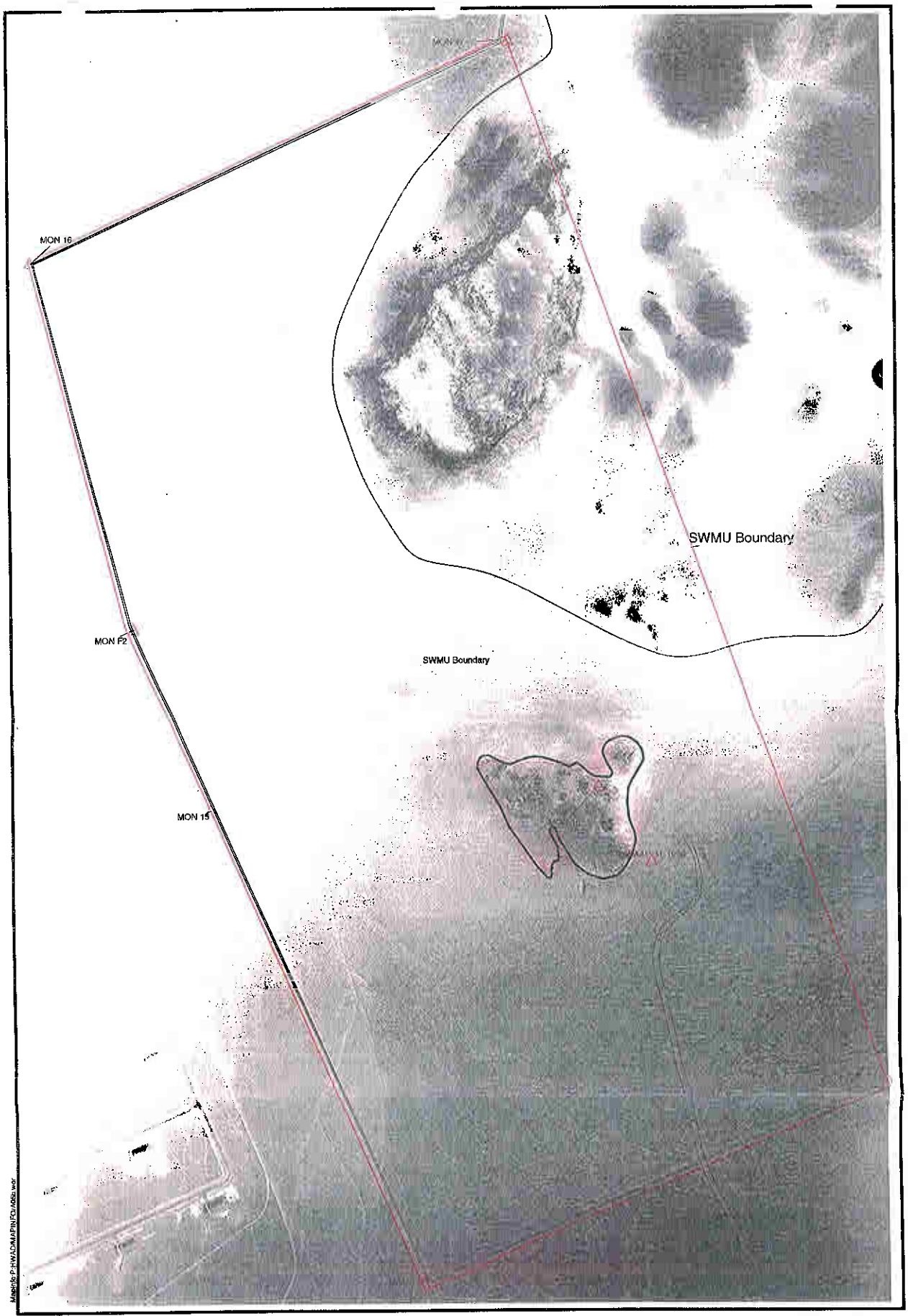
SWMU A05
Security Fence Map

Hawthorne Army Depot
Hawthorne, Nevada

Figure 1-1

Tetra Tech, Inc.

MapInfo:P:\HWA\DMAP\INFO\Gdb.wor



Legend:

Fence
SWMU Monument
Rock Outcrop

N

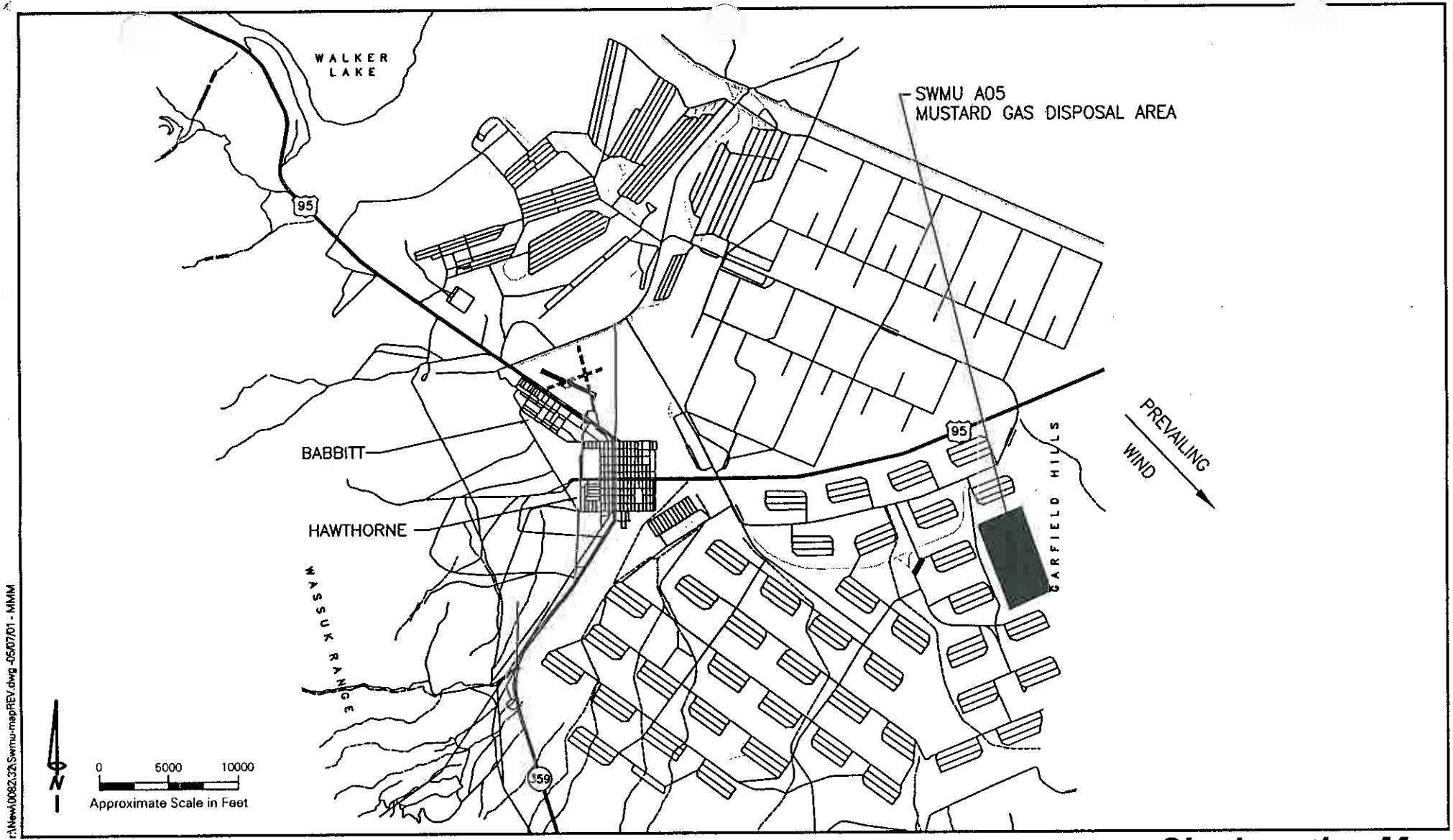
0 225 550
Approximate Scale in Feet

Tetra Tech, Inc.

Site Map
SWMU A05

Hawthorne Army Depot
Hawthorne, Nevada

Figure 1-2



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SOURCE: TETRA TECH FINAL DATA PACKAGE, 1996 (REV. 1997)

Site Location Map
SWMU A05
Mustard Gas Disposal Area
Hawthorne Army Depot
Hawthorne, Nevada

Tetra Tech, Inc.

Figure 1

APPENDIX A

SURVEY DATA

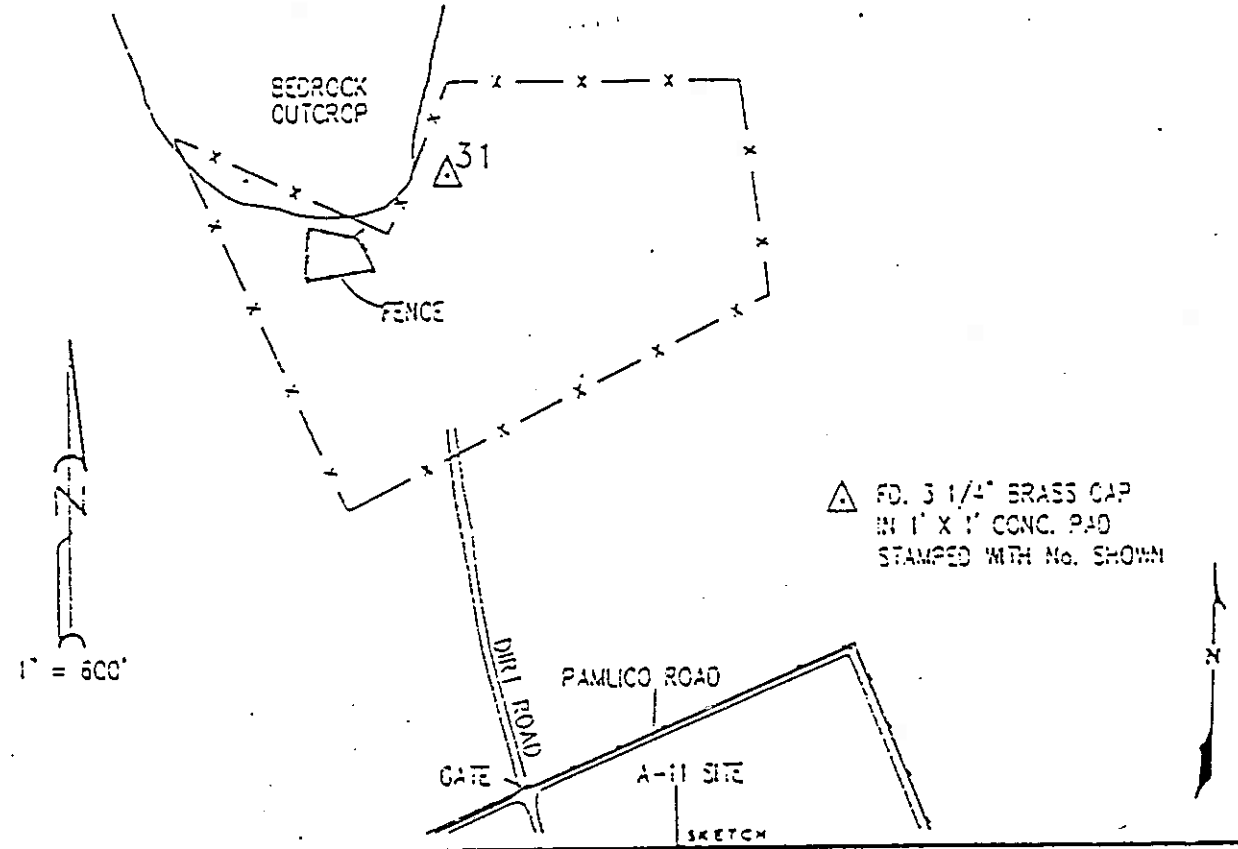
COUNTRY	TYPE OF MARK	STATION	
USA	BRASS CAP	31	
LOCALITY	STAMPING ON MARK	AGENCY (CAST IN MARK)	ELEVATION (FT) (M)
HAWTHORNE NEV.	31 A-5	COE HWAAP	4480.25
LATITUDE	LONGITUDE	DATUM	DATUM
38°30'18.72783" N	118°31'07.38581" W	NAD '27	NGVD '29
(NORTHING)(EASTING) (FT) (M)	(EASTING)(NORTHING) (FT) (M)	GRID AND ZONE	ESTABLISHED BY (AGENCY)
1367018.33	518489.87	NEVADA SP WEST	A.L.S.
(NORTHING)(EASTING) (FT) (M)	(EASTING)(NORTHING) (FT) (M)	GRID AND ZONE	DATE / ORDER
			1997 / 2ND

TO OBTAIN GRID AZIMUTH, ADD ° TO THE GEODETIC AZIMUTH

TO OBTAIN GRID AZ. (ADD)(SUB.) ° TO THE GEODETIC AZIMUTH

OBJECT	AZIMUTH OR DIRECTION (GEODETIC)(GRID) (MAGNETIC)	BACK AZIMUTH	GEOD DISTANCE (METERS) (FEET)	GRID DISTANCE (METERS) (FEET)
	° ' "	° ' "		

MONUMENT 31 - SWMU A-5
FROM HIGHWAY 95 TAKE MINE ROAD SOUTHEAST 3600 FEET TO 1ST AVENUE SOUTH, THEN NORTHEAST ON 1ST 2.1 MILES TO PAMLICO ROAD, THEN SOUTHEAST ON PAMLICO ROAD 3.2 MILES TO SITE A-11 AND MONUMENT 32. MONUMENT 31 CAN BE SEEN ON THE HILLSIDE TO THE NORTH - N 10° W, 2700 FEET. SEE MAP BELOW. MONUMENT IS A 3 1/4" BRASS CAP SET IN A 1' X 1' CONCRETE PAD AND IS MARKED WITH A 4" X 4" X 6' WOOD POST, PAINTED WHITE.



DA FORM 1 OCT 84 1959 REPLACES DA FORMS 1959 AND 1960, 1 FEB 57, WHICH ARE OBSOLETE.

DESCRIPTION OR RECOVERY OF HORIZONTAL CONTROL STATION
For use of this form, see TM 5-237; the proponent agency is TRADOC.

SWMU A05 Survey Data
Hawthorne Army Depot
Hawthorne, Nevada

SWMU	Point ID	Northing (feet)	Easting (feet)	Elevation
A05	HWAAP-31-1996	1367018.33	518489.87	4480.25
A05	Monument 13	1365659.52	519824.37	NE
A05	Monument 14	1364513.913	517023.86	NE
A05	Monument 15	1367347.575	515765.17	NE
A05	Monument 16	1370740.00	514840.00	NE
A05	Monument 17	1371971.517	517842.08	NE
A05	Monument 18	1367480.213	518185.77	NE
A05	Monument F2	1368461.937	515347.00	NE
A05	Existing Fence	1366903.10	518076.30	NE
A05	Existing Fence	1366868.80	518251.30	NE
A05	Existing Fence	1366781.40	518279.80	NE
A05	Existing Fence	1366751.20	518067.50	NE
A05	Proposed Fence	1367180.00	517660.00	NE
A05	Proposed Fence	1366890.00	518320.00	NE
A05	Proposed Fence	1367320.00	518520.00	NE
A05	Proposed Fence	1367330.00	519430.00	NE
A05	Proposed Fence	1366700.00	519520.00	NE
A05	Proposed Fence	1366080.00	518190.00	NE
A05	SL-1	1366628.02	518590.73	NE
		1366965.26	519045.81	NE
A05	SL-2	1366589.47	518700.62	NE
		1366971.37	518856.97	NE
A05	SL-3	1366802.38	517944.31	NE
		1366880.84	518375.62	NE
A05	SL-4	1365957.41	518400.68	NE
		1366864.68	518223.13	NE

Notes:
NE = Not established.
Coordinate data based on electronic map file using the NAD 1927 datum.
Elevation data based on surveyors map using NGVD 1929 datum.

APPENDIX B

ANALYTICAL DATA FROM IT'S 1988 INVESTIGATION

TABLE 3-9

RESULTS OF GEOPHYSICAL SURVEY
(MUSTARD DISPOSAL AREA)

FEATURE[1] NUMBER	APPROXIMATE[2] DIMENSIONS (feet)	POSSIBLE[3] CONTENTS	APPROXIMATE[4] DEPTH (feet)	LOCATED[5] WITH/BY	COMMENTS	RECOMMENDATIONS
P-1	<10x10	M	<5	EM-31	Associated with OA-1	1 test pit
P-2	10x15	M	5	EM-31, V-91	-	1 test pit*
P-3	<10x10	M	<5	EM-31, V-91	Associated with OA-2	1 test pit
P-4	15x20	M	5	EM-31, FO	Associated with OA-3	1 test pit
P-5	10x15	M	5	EM-31, V-91	Associated with OA-5	1 test pit
P-6	15x15	LM	5	EM-31	-	1 test pit
P-7	15x20	M	5	EM-31, V-91	-	1 test pit
P-8	25x20	LM	5	EM-31	-	1 test pit
P-9	15x15	LM	5	EM-31, V-91	-	1 test pit
P-10	15x25	M	5	EM-31, V-91	Associated with OA-6	1 test pit*
P-11	20x30	M	5	EM-31, V-91	-	1 test pit*
?	15x40	M	5	EM-31, V-91	Associated with OA-9	1 test pit*
P-13	15x20	LM	5	EM-31, FO, V-91	-	1 test pit
P-14	20x20	LM	5	EM-31	-	1 test pit
P-15	20x15	M	5	EM-31, V-91	-	1 test pit
P-16	10x15	NA	<5	EM-31, FO	Evidence of backfilled open pit from previous investigation	1 test pit
P-17	30x55	NA	NA	FO	250 ml amber bottles and crates on surface, associated with OA-11	Sample any liquid-bearing bottles
T-1	30x90	M, MG, MH?	>10	EM-31, FO	Staining (soil discoloration) on surface	1 trench (begin at stake 55 and continue north)
T-2	30x90	M, MG, MH?	>10	EM-31, V-91 FO	-	1 trench (begin at stake Metals and continue north)

TABLE 3-9 (CONTINUED)

RESULTS OF GEOPHYSICAL SURVEY
(MUSTARD DISPOSAL AREA)

FEATURE[1] NUMBER	APPROXIMATE[2] DIMENSIONS (feet)	POSSIBLE[3] CONTENTS	APPROXIMATE[4] DEPTH (feet)	LOCATED[5] WITH/BY	COMMENTS	RECOMMENDATIONS
OA-8	20x220	LM?, MG? NM?	<10	FO, EM-31	Possible scattered subsurface metalic debris	1 pit at location H Figure 3-14*
OA-9	80x90	LM?, MG?, NM	NA	FO, EM-31	Associated with P-12 staining (soil discoloration) on surface	1 trench between stakes 15 and 25*
OA-10	15x20	NA	NA	FO	Disturbed area associated with P-16	-
OA-11	50x400	NA	NA	FO	Disturbed area associated with P-17	-
OA-12	150x50	NA	NA	FO, EM-31	Disturbed area due to a mudflow/boulder field and possible disposal activity	1 pit in north western corner adjacent to OP-7*

[1] P = pit
T = trench
OP = open pit/trench
OA = disturbed area

Dimensions are approximate and are rounded off to nearest five feet
Dimensions of open pits are approximate dimensions of open pit not including adjacent stockpile of soil and debris included in the staked area and shown on Figure 3

[3] M = metallic debris such as drums and mustard disposal tools
LM = low concentrations of metallic debris
MG = mustard gas disposal as evidenced from surface soil discoloration (staining)
NM = nonmetalic debris such as wooden crates, etc.; evidenced by surface exposure of debris
NA = no information or not applicable
? = uncertainty

[4] Approximate depths are gross approximations determined from surface dimensions and observations of open pits and trenches.

[5] EM-31 = Geonics EM-310L Terrain Conductivity Meter
V-91 = Scintrex V-91 cesium magnetometer
FO = Field observations of surface disturbances. Only included when important in locating feature.
NOTE: The boundaries of pits and trenches were defined using the EM-31 and surface disturbances.

[6] * = Strongly recommend that the pits be excavated in these areas; for others, do all pits if time permits; otherwise, sample 25 to 50 percent in order to characterize..

Stakes denoted as 15 to 75 show locations of surface staining (discolored soil zones) where pits are recommended.

[7] Many of the conclusions in the table are not directly correlative with geophysical interpretation but are derived from field observations.

REFERENCE: Mustard Area Investigative Report (IT Corp, September 1988).

TABLE 3-10 (CONTINUED)

SUMMARY OF EXLORATORY PIT DATA[1]
(MUSTARD DISPOSAL AREA)

PIT NO.	DATE	ITEM		M-18[2] RESULTS
		DESCRIPTION	DEPTH	
DA-8	9/9	Small pieces of scrap metal	4 ft	Negative
DA-9	9/9	Small pieces of scrap metal	3 ft	Negative
T-3	9/12	Lime (30 ft from south edge)	15 ft	Negative
T-3	9/12	Wood, lime (45 ft from south edge)	15 ft	Negative
T-3	9/12	(2) block of lime (10 ft from east end)	7 ft	Negative
T-3	9/12	Bleaching powder cans (20 ft from east end)	6 ft	Negative
T-3	9/12	Blocks of lime (30 ft from east end)	3 ft	Negative
T-3	9/12	Wood (2x4, 4x4) (40 ft from east end)	18 ft	Negative
T-3	9/13	Pieces of wood (4x4) with writing (63 ft from east end)	15 ft	Negative
T-3	9/13	Block of lime (85 ft from east end)	5 ft	Negative
T-3	9/13	Bleaching powder cans (132 ft from east end)	10 ft	Negative
T-3	9/13	100 lb bomb casing (150 ft from east end)	10 ft	Positive
T-3	9/13	Lime (Powder) (175 feet from east end)	5 ft	Negative

(1) Table summarizes items found during TEU subsurface investigation.
(2) M-18 field chemical detector used to identify mustard agent.

Source: TEU's After Action Report (Duty Officer's Logs) Appendix 0.3.

TABLE 3-11

SOIL SAMPLE COLLECTION LOG
(MUSTARD DISPOSAL AREA)

SAMPLE SITE	SAMPLE[2] LOCATION	DEPTH (FT)	LAB NO.	TEU NO.	M-18[1] RESULTS
OA-8	Base	10	88-9-19-16	1	NEG
T-4	Base (stake J34)	10	88-9-19-4	2	NEG
T-4	Base (stake J34)	10	88-9-19-17	3	NEG
OP-3	Base sample	10	88-9-19-27	4	NEG
OP-7	Base sample	14	88-9-19-5	5	NEG
-	Background N. of OA-8	9	88-9-19-20	6	NEG
-	Background S. of OA-8	9	88-9-19-15	7	NEG
-	Background N. of OP-4	10	88-9-19-11	8	NEG
-	Background S. of OP-4	9	88-9-19-6	9	NEG
-	Background W. of P-14	4	88-9-19-21	10	NEG
T-3	Base sample (Area 1)	15	88-9-19-2	11	NEG
T-3	Lime sample (Area 1)	15	88-9-19-29	12	NEG
T-3	Center sample (Area 1)	8	88-9-19-25	13	NEG
T-3	Surface (Area 1)	3	88-9-19-24	14	NEG
T-3	Surface (Area 2)	3	88-9-19-30	15	NEG
T-3	Center (Area 2)	8	88-9-19-28	16	NEG
T-3	Base (Area 2)	15	88-9-19-19	17	NEG
T-3	Center (Area 3)	8	88-9-19-1	18	NEG
T-3	Surface (Area 3)	3	88-9-19-31	19	NEG
T-3	Bomb scraping (Area 4)	10	88-9-19-10	20	NEG
T-3	Lime Sample (Area 4)	5	88-9-19-18	21	NEG
T-3	Base (Area 4)	15	88-9-19-23	22	NEG
T-3	Base (Area 4)	15	88-9-19-14	23	NEG
-	Background N.W. of P-15	12	88-9-19-7	24	NEG
-	Background S.W. of OP-8	4	88-9-19-3	25	NEG
-	Background N. of P-16	10	88-9-19-26	26	NEG
-	Background N. of T-3	10	88-9-19-22	27	NEG
-	Background N.W. of T-3	6	88-9-19-9	28	NEG
-	Background S. of T-3	10	88-9-19-12	29	NEG
-	Background N. of OA-4	7	88-9-19-13	30	NEG
-	Background S.W. of T-3	8	88-9-19-8	31	NEG

All samples shown on this page were received at CROEC Lab on September 19, 1988.

Source: TEU After Action Report (Appendix O.3) and CROEC Mustard Area Laboratory Report (Appendix F.4).

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TABLE 4
RESULTS OF ANALYSIS OF SOILS

Laboratory Number	pH		Active Chlorine, ppm	Chloride Ion, ppm	TDG Recovery, %
88-9-19-1	9.78	9.08	<0.23	58	89.3
88-9-19-2	8.98	9.33	<0.23	24	56.1
88-9-19-3	9.02	9.80	<0.23	12	85.9
88-9-19-4	9.87	9.99	0.29	11	80.3
88-9-19-5	8.91	9.06	<0.23	20	70.3
88-9-19-6	8.77	8.97	<0.23	8	91.3
88-9-19-7	9.40	9.46	<0.23	8	86.2
88-9-19-8	9.18	9.31	<0.23	18	78.6
88-9-19-9	9.65	9.62	0.26	22	90.1
88-9-19-10	8.99	8.90	<0.23	41	71.2
88-9-19-11	9.71	9.63	2.85	38	75.4
88-9-19-12	10.07	10.02	0.61	20	78.1
88-9-19-13	9.93	9.77	0.75	26	88.1
88-9-19-14	9.89	9.88	0.53	30	89.2
88-9-19-15	9.89	9.83	<0.23	31	75.9
88-9-19-16	9.48	9.34	0.46	33	94.8
88-9-19-17	9.46	9.49	<0.23	20	89.8
88-9-19-18	11.53	11.58	6.00	132	64.0
88-9-19-19	9.42	9.24	<0.23	40	100.8
88-9-19-20	9.90	9.93	1.71	51	82.2
88-9-19-21	10.55	9.82	<0.23	30	86.4
88-9-19-22	10.01	10.05	0.44	18	81.9
88-9-19-23	8.18	8.61	<0.23	66	94.2
88-9-19-24	9.75	9.79	<0.23	26	92.9
88-9-19-25	9.28	8.68	<0.23	42	91.5
88-9-19-26	9.50	9.49	0.48	24	95.1
88-9-19-27	9.71	9.55	0.60	31	90.9
88-9-19-28	9.45	9.41	0.36	32	75.9
88-9-19-29	11.64	11.58	5.04	120	95.5
88-9-19-30	9.44	9.42	0.39	58	79.3
88-9-19-31	8.50	11.34	nd	nd	nd

nd-not determined. sample 88-9-19-31 was consumed in spiking experiments.

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TABLE 2
SAMPLE IDENTIFICATION AND CROSS REFERENCE

Serial Number 19 Sept 88	Sampling site Soil sample	Laboratory Number
1	DA-8 base	88-9-19-16
2	T-4 base stake J34	88-9-19-4
3	T-4 base stake J34	88-9-19-17
4	OP 3 base sample	88-9-19-27
5	OP 7 base sample	88-9-19-5
6	N DA-8 background	88-9-19-20
7	S DA-8 background	88-9-19-15
8	N OP-4 background	88-9-19-11
9	S OP-4 background	88-9-19-6
10	W P-14 background	88-9-19-21
11	T-3 base sample (Area 1)	88-9-19-2
12	T-3 line sample (Area 1)	88-9-19-29
13	T-3 center sample (Area 1)	88-9-19-25
14	T-3 surface (Area 1)	88-9-19-24
15	T-3 surface (Area 2)	88-9-19-30
16	T-3 center (Area 2)	88-9-19-28
17	T-3 base (Area 2)	88-9-19-19
18	T-3 center (Area 3)	88-9-19-1
19	T-3 surface (Area 3)	88-9-19-31
20	T-3 bomb scraping (Area 4)	88-9-19-10
21	T-3 line sample (Area 4)	88-9-19-18
22	T-3 base (Area 4)	88-9-19-23
23	T-3 base (Area 4)	88-9-19-14
24	1 NW P-15 background	88-9-19-7
25	SW OP-8 background	88-9-19-3
26	N P-16 background	88-9-19-26
27	N T-3 background	88-9-19-22
28	NW T-3 background	88-9-19-9
29	S T-3 background	88-9-19-12
30	N DA-4 background	88-9-19-13
31	SW T-3 background	88-9-19-8

FINAL
REMEDIAL INVESTIGATION REPORT ADDENDUM
SOLID WASTE MANAGEMENT UNIT A05
MUSTARD GAS DISPOSAL AREA

HAWTHORNE ARMY DEPOT
HAWTHORNE, NEVADA

Contract No. DACW05-99-D-0027
Delivery Order No. 08

June 2001

Prepared for:

US Army Corps of Engineers
Sacramento District
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TABLE OF CONTENTS

ADDENDUM SECTION 1
PURPOSE AND OBJECTIVES

The purpose of implementing a remedial action at SWMU A05 is to reduce potential exposure to suspected chemicals so that a no further action closure authorization, with restrictions, can be proposed to the NDEP. NDEP is the lead regulatory agency for the Installation Restoration Program at the Hawthorne Army Depot (HWAD).

The objective of this remedial action is to further limit unauthorized access to the southern portion of SWMU A05 where chemical agent has been disposed of. SWMU A05 is in HWAD's secure southern magazine area and is monitored by the HWAD security contractor. The SWMU is enclosed on three sides by a barbed wire fence. To meet the remedial action objective, an interior security fence with a locked gate was constructed to completely enclose the known chemical weapons disposal sites. Warning signs posted on this fence designate the potential hazard inside the fence. Additionally, Tetra Tech (Tt) recommended that no activities be allowed at SWMU A05, within either the boundary fence or the interior security fenced area.

ADDENDUM SECTION 2
SITE HISTORY

SWMU A05 covers approximately 400 acres in the eastern portion of HWAD's south magazine area, approximately two miles south of US Highway 95 at the foot of the Garfield Hills. Based on interviews with HWAD personnel, the southern portion of SWMU A05 was used in the disposal and chemical destruction of the toxic agents mustard, phosgene, and cyanogen chloride during the 1940s. The Navy investigated SWMU A05 in 1971 and International Technology Corporation (IT) investigated it in 1988. A contiguous group of disposal sites, covering 18 acres in the southern portion of SWMU A05, were identified and trenched during these investigations. Traces of mustard were found inside one bomb case and in two soil samples during the 1971 Navy excavations of trenches T-1 and T-3 (Figure 1-1). However, in its 1988 investigation, IT found no evidence of mustard or other target analytes in 63 trench excavation soil samples.

In investigations at SWMU A05 from 1993 to 1997 Tt used nonintrusive geophysical mapping techniques to identify disposal sites and assess the groundwater level beneath the SWMU. We mapped disposal sites using airborne ground-penetrating radar over 300 acres. The objective of the study was to explore for additional disposal sites within, and peripheral to, the contiguous group of previously investigated pits and trenches and to verify the locations of the previously investigated disposal trenches. The results showed four potential disposal sites outside the area of known disposal trenches in the southern portion of the SWMU. These sites are designated DA-1, P-1, DA-11 and P-17 (Figure 1-1). From interviews with base operations personnel, Tt assessed these sites as small, isolated, disturbed soil areas where chemical agents are unlikely to have been disposed of.

IT's 1988 surface geophysical surveys and Tt's 1994 airborne geophysical surveys appear to have defined all of the other disposal trenches at SWMU A05. The extent of the defined disposal areas is in approximately 18 contiguous acres in the southern portion of the SWMU.

The geophysical study of the groundwater was a refraction seismic survey that produced two subsurface profiles in the area of the disposal site. These profiles showed a seismic strata at approximately 150 to 300 feet below the ground surface where the shallowest groundwater likely occurs. Because of the arid climate at HWAD, the depth to the first groundwater level at this SWMU, and the subsurface sampling results collected at depths of 20 to 30 feet that were nearly all non-detect, there is very little risk that the residual mustard gas concentrations that persist in the subsurface soils would migrate to the groundwater. SWMU A05 is also very remote, with no producing groundwater wells within several miles of the disposal area that could cause potential receptor pathways. Several meetings with the NDEP, USACE, and HWAD have discussed this issue, concluding that conclusive groundwater data for SWMU A05 is not economically prudent nor technically necessary given the high costs to conduct the investigation, and the low risk of groundwater contamination. Therefore, the NDEP agreed that no further groundwater investigation is necessary at SWMU A05, and that the issue of groundwater contamination can be closed at this SWMU.

Also, Tt concludes from these remedial investigations that only small amounts of chemical agents, if any, persist in the subsurface at the known disposal trench locations and that removal and disposal of these agents, if found, would be both risky and costly. Furthermore, the only likely exposure would be from surface exposure or subsurface exposure during excavation. Therefore, to achieve closure of this site, Tt recommends restricting all surface and subsurface activities and constructing a security fence to enclose the identified 18-acre disposal area.

ADDENDUM SECTION 3
FENCE ENCLOSURE

3.1 FENCE ENCLOSURE LOCATION

During the 1997 remedial investigation of SWMU A05, Tt inspected the site and surveyed the ground surface for fence construction. This work included an exposed ordinance sweep by qualified HWAD personnel of the proposed fence construction area and a site inspection to ensure that the proposed fence would enclose the known disposal sites. Worldwide Land Surveyors, Inc., of Concord, California, using a global positioning system, surveyed all corner post locations and fence lines (Figure 1-1). The corner locations were marked with a rebar and cap monument, and the perimeter fence lines were marked with survey lath.

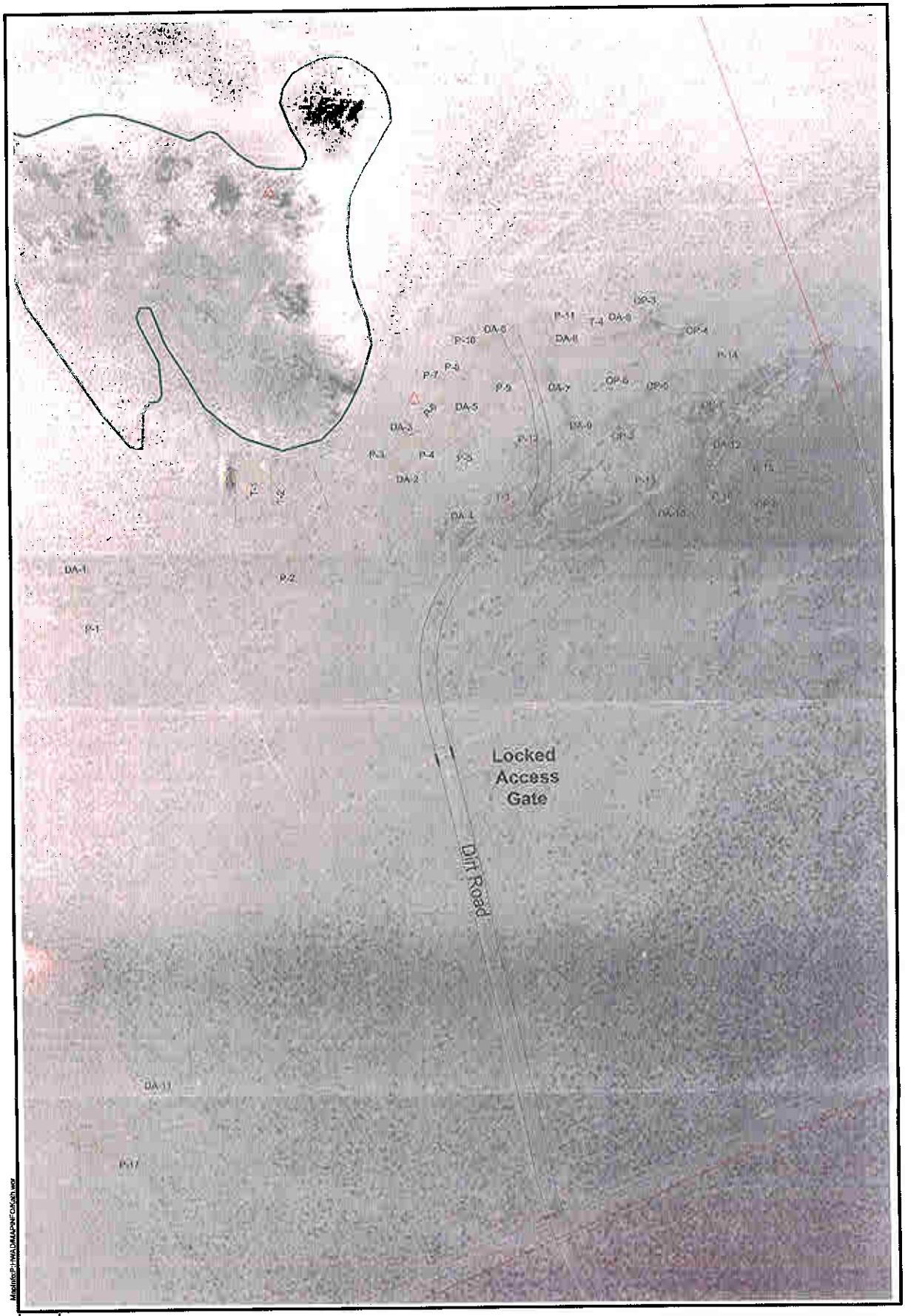
3.2 FENCE ENCLOSURE CONSTRUCTION

After HWAD and the USACE agreed on the fence location, they issued a scope of work and budget to Tetra Tech to construct the security fence. The all-metal fence encloses an irregular six-sided area (Figure 1-1) and is four feet high and 5,540 feet long. Corner and side termination posts are seven feet long, with three feet set in concrete below ground. Angled braces are set in concrete two feet below ground and are attached to the corner posts with metal brackets. Side termination points are square-set, and two posts, spaced five feet apart, are set three feet in concrete and are wired together by tensioned diagonal supports. The barbed wire is supported by six-foot T-posts driven two feet below ground. The five-strand four-point barbed wire is attached to the T-posts with heavy-gauge wire. A locked 12-foot wide gate on the south side of the enclosure provides access to the enclosure. Gate support posts are set in concrete three feet below ground. Metal signs warning of the potentially hazardous compounds inside the enclosure are attached at eleven evenly spaced locations around the fence.

ADDENDUM SECTION 4
CONCLUSIONS

The closed security fence at SWMU A05 has been constructed to the standards listed in the scope of work. By restricting foot and motorized traffic, the fence greatly reduces the risk of accidental human exposure to potentially hazardous compounds inside the enclosure. Additionally, the area is isolated by the barbed wire fence, by the south magazine perimeter fence, and by the HWAD base operator's continuous 24-hour security patrol. Furthermore, HWAD has documented that no surface or subsurface activities are allowed within the security fence or at any other areas within the SWMU A05 boundary. Lastly, the NDEP agreed that further groundwater investigations are not necessary at SWMU A05, and that groundwater contamination is not an issue at this SWMU.

FIGURE



Legend:

- Existing Fence
- SWMU Monument
- Rock Outcrop
- Inferred Extent of disrupted Soil from Radar
- Security Fence

- P Pit from Radar
- Op Open Pit
- T Trench from Radar
- DA Disturbed Area from Radar

N

0 150 300

Approximate Scale in Feet

SWMU A05
Security Fence Map

Hawthorne Army Depot
Hawthorne, Nevada

Figure 1-1

Tetra Tech, Inc.